

REMARKS

Reconsideration of the above-identified patent application in view of the amendment above and the remarks below is respectfully requested.

No claims have been canceled or added in this paper. Claims 53, 55 and 56 have been amended in this paper. Therefore, claims 44-58 are pending and are under active consideration.

Claims 44-49, 52 and 58 stand rejected under 35 U.S.C. 102(b) "as being anticipated by Ledjeff et al (5863672)." In support of the rejection, the Patent Office states the following:

Ledjeff et al disclose a polymeric solid electrolyte in the form of a membrane which membrane is permeable to either cations or to anions. Ion conductivity is present in an aqueous environment for cation conductive polyethers, if the polymer is securely anchored, that is if the polymer is secured by chemical bonding, carbonic acid groups and or sulphonic acid groups. The membrane is further shown to have quaternary ammonium groups and pyridinium groups. Examples of cation conductive polymers are sulphonated polysulphones, polyether sulphones or polyether ketones.

Ledjeff et al anticipates the applicants instant invention as set forth above with respect to the instant claims. Ledjeff et al discloses a persulfonic acid membrane with a quaternary salt or pyridinium salt that is secured to the membrane (i.e. polymerized). It appears that Ledjeff et al introduces the cationic monomer into the entirety of the membrane and therefore, both the periphery and the interior regions of the membrane are introduced with the cationic monomer and therefore the dependent claims are anticipated.

Therefore, the prior art of Ledjeff et al anticipates the applicants instant invention.

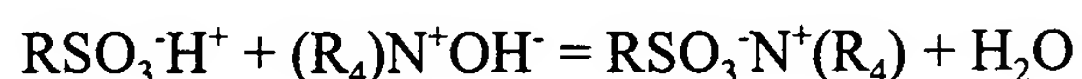
Applicants respectfully traverse the subject rejection. The present invention is based, at least in part, on the discovery that, by treating a desired area of a **proton** exchange membrane so that the membrane protons and water residing therein are replaced with a **cationic polymer**, one can alter the characteristics of the **proton** exchange membrane in the treated area, such as by improving its

tensile strength, by decreasing its proton conductivity, by decreasing its water and gas permeability, and/or by reducing its membrane acidity. Moreover, because the cationic polymer remains substantially stationary within the proton exchange membrane, the effects of the treatment may be confined to the treated area. Therefore, the treatment of the proton exchange membrane may be confined, for example, to the periphery of the membrane or may be directed to both the periphery of the membrane and to interior regions separating and defining active areas of the membrane.

Accordingly, the present invention is directed to a method of preparing a composite proton exchange membrane that comprises the steps of (a) providing a proton exchange membrane; (b) introducing a cationic monomer into one or more desired areas of the proton exchange membrane; and (c) effecting the polymerization of the cationic monomer. As can be appreciated, by incorporating the **cationic polymer** into one or more desired areas of the **proton** exchange membrane, one **replaces** the membrane **protons** that had previously been present in the **proton** exchange membrane with the **cationic polymer**. This replacement of **protons** with the **cationic polymer** typically **reduces** the conductivity of the **proton** exchange membrane for **protons**; for this reason, the replacement of protons with the cationic polymer is in many cases confined to the periphery of the membrane and/or to interior regions of the membrane separating and defining active areas of the membrane.

Ledjeff et al. neither teaches nor suggests a method of preparing a composite membrane that comprises the steps of: (a) providing a proton exchange membrane; (b) introducing a cationic monomer into one or more desired areas of the proton exchange membrane; and (c) effecting the polymerization of the cationic monomer. Instead, Ledjeff et al. relates to certain polymeric solid electrolyte membranes that are capable of transporting **either** cations or anions. One such type of

membrane is a cation-conductive polymer, i.e., a polymer that transports cations. This cationic-conductive polymer has negatively-charged groups like carbonic acid groups and/or sulfonic phosphonic acid groups securely anchored to a polymer. Examples of cation-conductive polymers of this type are sulfonated polysulfones, polyether sulfones or polyether ketones. Another type of membrane is an anionic-conductive polymer, i.e., a polymer that transports anions. This anionic-conductive polymer has positively-charged groups like amine groups, quaternary ammonia groups or pyridinium groups securely anchored to a polymer. The cationic-conductive polymer membranes and the anionic-conductive polymer membranes of Ledjeff et al. are **discrete or separate from one another**, and either one could be used in a polymer electrolyte membrane fuel cell. Ledjeff et al. does not teach or suggest a **single** membrane that has both cationic-securely-anchored conductive polymer groups (i.e., RSO_3H^+ , sulfonic acid) and anionic-securely-anchored conductive polymer groups (i.e., $(\text{R}_4)\text{N}^+\text{OH}^-$, quaternary ammonium hydroxide) since such a combination would result in the neutralization or inactivation of the securely anchored conductive groups, thereby preventing the groups from supporting hydrogen ion or hydroxide ion transport, respectively.



Such a single membrane would have significantly inferior water uptake, ionic conductivity and transport properties and would not be useful for obtaining effective and efficient fuel cell performance.

In short, as can be seen, Ledjeff et al. does not start with a **proton** exchange membrane and **then** modify the proton exchange membrane **by introducing a cationic monomer** into an area of the proton exchange membrane and then **effecting the polymerization** of the cationic monomer.

Therefore, for at least the above reasons, claim 44 is patentable over Ledjeff et al.

Claims 45-49, 52 and 58 depend from claim 44. Therefore, based on their respective dependencies from claim 44, claims 45-49, 52 and 58 are also patentable over Ledjeff et al. Moreover, claims 45-49, 52 and 58 recite various features that are neither taught nor described by Ledjeff et al.

Accordingly, for at least the above reasons, the subject rejection should be withdrawn.

Claims 44-49, 52 and 58 stand rejected under 35 U.S.C. 102(b) “as being anticipated by Sorenson et al (6011074).” In support of the rejection, the Patent Office states the following:

Sorenson et al disclose an ion exchange membrane having a cation monomer of an organic quaternary salt. When the cations in such polymer are subsequently exchanged with hydrogen or metal ions which typically are smaller size than that of organic quaternary cations, a relatively stable morphology of the polymers results in a polymer microstructure having significantly different pore characteristics than a polymer microstructure of the same ion exchange polymer which has not been prepared utilizing the cationic quaternary salt. See col. 3, lines 16-28. The pore characteristics of the ion exchange polymer having the organic quaternary salt have enhanced ability to uptake water or other polar fluids used to expand the polymer. See col. 3, lines 30-31. By appropriate selection of the alkyl, aryl, aralkyl or cyclo-alkyl groups present in the quaternary ammonium compound utilized to react with the starting ion exchange polymer, polymers having improved catalytic activity and membranes showing improved performance in electrolytic cells and fuel cells, as well as improved membranes useful in the separation of miscible liquids and gases is achieved. See col. 3, lines 43-50. The electrical resistivity of the polymer of the ion exchange polymer with quaternary ammonium salt is improved about 2 to 4 times greater than the electrical resistivity of the membrane without the salt. See col. 3, lines 56-60. When the polymer is utilized as a membrane in a chlor-alkali cell, the increased fluid uptake of the membrane results in the membrane having a relatively low resistivity, thereby improving the performance of the membrane. See col. 3, lines 61-65. See example 2 for the preparation of the perfluorosulphonic acid polymer having the quaternary ammonium cations. It appears that Sorenson et al introduces the cationic monomer into the entirety of the membrane and therefore, both the periphery and the interior

regions of the membrane are introduced with the cationic monomer and therefore the dependent claims are anticipated.

The prior art of Sorenson et al anticipates the applicants instant invention as shown by way of the disclosure to Sorenson et al above with respect to the instant claims as presented.

Applicants respectfully traverse the subject rejection. Sorenson et al. teaches, at col. 4, lines 21-32, a two-step process for preparing an ion-exchange polymer: In the first step, for example, an expanded fluoropolymer having pendant sulfonic acid groups (in its acid or metal salt form) and equivalent weight of about 800 is reacted with a quaternary alkyl ammonium hydroxide having a molecular weight of 350 or greater. In the second step, the quaternary ammonium cations are removed from the polymer and **replaced**, using ion exchange, with metal or hydrogen cations.

At col. 6, lines 34-49, Sorenson et al. further describes its polymer as follows:

The polymer of the invention is prepared in one embodiment using at least two essential process steps: (1) reaction of a starting organic, anionic, ion-exchange polymer in the acid or salt form (which is also preferably in a finely-divided state) with a quaternary ammonium compound having organic groups such that nitrogen containing cations are attached to all or substantially all fixed anionic groups in the starting ion-exchange polymer, and (2) removal of all or substantially all of the nitrogen-containing cations containing an organic group, as described above, so that all or substantially all of the original fixed anionic ion-exchange groups in the ion-exchange polymer are converted back to the acid or salt form. Prior to process step (2) above, the polymer can be processed, including thermal processing, to provide a film or membrane of a desired thickness as a sheet or coating.

As noted by the Patent Office, the process of exchanging a cation of an organic quaternary ammonium salt into the fluorocarbon sulfonic acid polymer results in a polymer microstructure having significantly different pore characteristics than a polymer microstructure of the same ion-exchange membrane that has not been prepared utilizing the cationic quaternary salt. However, it

is only after the membrane is returned, by ion exchange, to the H^+ ion or metal ion form that the membrane possesses enhanced ability to uptake water or other polar fluids to expand the polymer. The fluorocarbon sulfonated polymer membrane in the quaternary ammonium form would have a significantly decreased ability to take up water. The quaternary ammonium ion is large and expands the polymer structure; however, the sulfonated polymer membrane has difficulty taking up water because of the large size of the quaternary ammonium ion and its poor water uptake properties. Also, the ionic conductivity of the sulfonated polymer membrane, in the quaternary hydroxide ion form, is significantly decreased and it would not be suitable for fuel cell or electrolyzer use. It is only after the sulfonated polymer membrane is returned to the hydrogen-ion form, by ion exchange, that it has enhanced-water uptake properties and ionic conductivity. Sorenson et al. teaches using the quaternary salts to swell the perfluorocarbon sulfonic acid membrane structure and then **removing these same groups** by ion exchange to return the sulfonated polymer membrane to the hydrogen or metal cation form, which now has a resulting permanently swollen structure and has **enhanced** water uptake and ionic conductivity properties.

The claimed method differs notably from the above-described method of Sorenson et al. in that, pursuant to the claimed method, cationic monomers (containing, for example, quaternary ammonium or amine groups) are exchanged into selected regions of the proton exchange membrane and are **subsequently polymerized**. As a result of this **polymerization of the cationic monomers**, these cationic groups are **permanently** retained within the proton exchange membrane by virtue of the large molecular size of the resulting oligomers. The effect of these cationic polymers is to permanently **reduce** the water uptake and ionic conductivity of the membrane, as well as to inactivate select regions of the membrane and to provide structural reinforcements to the membrane.

In short, the quaternary ammonium and other cationic groups of the claimed invention remain in the membrane permanently and are not exchanged out of the sulfonated polymer membrane as in Sorenson et al. Sorenson et al. fails to teach or to suggest the use of a cationic monomer that is subsequently polymerized.

Accordingly, for at least the above reasons, the subject rejection should be withdrawn.

Claims 50 and 51 stand rejected under 35 U.S.C. 103(a) “as being unpatentable over Sorenson et al (6011074) or Ledjeff et al (5863672).” In support of the rejection, the Patent Office states the following:

Both Sorenson et al and Ledjeff et al are disclosed above in the 35 USC 102 rejections above.

Sorenson et al and Ledjeff et al do not disclose heating or irradiating to effect polymerization.

The subject matter as a whole would have been obvious to one having ordinary skill in the art at the time the instant invention is made because both irradiating and heating are conventional means of effecting polymerization and both methods are known to one having ordinary skill in the art. As shown in both Sorenson et al and Ledjeff et al, the reaction of the component effects the polymerization and that is due to the heat of the reaction which allows the polymers to polymerization. Irradiation does the same thing, it effectively raises the temperature to cause the polymers temperature to rise and effect the polymerization. Therefore, the prior art of Sorenson et al or Ledjeff et al along with common knowledge in the art render the applicants instant invention obvious for the reasons set forth above.

Applicants respectfully traverse the subject rejection. Claims 50 and 51 depend from claim 44. Claim 44 is patentable over Sorenson et al. or Ledjeff et al. for at least the reasons given above. Therefore, based at least on their respective dependencies, claims 50 and 51 are patentable over Sorenson et al. or Ledjeff et al. Moreover, as explained above, neither Sorenson et al. nor Ledjeff

et al. contemplates introducing a cationic monomer into a proton exchange membrane and then effecting the polymerization of the cationic monomer. Consequently, because polymerization is not even contemplated by Sorenson et al. and Ledjeff et al., the particular polymerization effecting steps recited in claims 50 and 51 cannot possibly be taught or suggested by Sorenson et al. or Ledjeff et al.

Accordingly, for at least the above reasons, the subject rejection should be withdrawn.

Claims 53-57 stand objected to “as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.”

In response to the above, Applicants have rewritten claims 53, 55 and 56 in independent form, claims 54 and 57 depending from claims 53 and 56, respectively. Accordingly, the subject objection has been overcome and should be withdrawn.

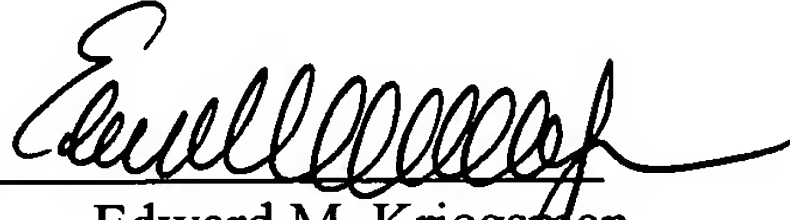
In conclusion, it is respectfully submitted that the present application is in condition for allowance. Prompt and favorable action is earnestly solicited.

If there are any fees due in connection with the filing of this paper that are not accounted for, the Examiner is authorized to charge the fees to our Deposit Account No. 11-1755. If a fee is

required for an extension of time under 37 C.F.R. 1.136 that is not accounted for already, such an extension of time is requested and the fee should also be charged to our Deposit Account.


Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Mail Stop Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on January 22, 2007


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